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Title: Managing *Lygus* bugs in cotton through improved almond orchard floor management: A regional IPM approach

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Acknowledgements

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Abstract:

Lygus bugs are important insect pests in row crops grown in the San Joaquin Valley. In cotton fields they are a key pest that have important implication in the overall pest management approach and crop production profitability. They are migratory and move into cotton fields from other sources including almonds, sugar beets, safflower, tomatoes, and alfalfa. This project was designed to take a regional approach to *Lygus* management by mitigating the movement of *Lygus* from neighboring crops to into cotton. It established principles of management for vegetation cover between almond rows and successfully reduced *Lygus* migration into lima beans. It demonstrated that managing a preferred host such as alfalfa was beneficial in limiting *Lygus* migrations into adjoining cotton. Limiting migrations reduces the need for insecticide intervention, fosters conservation of natural enemies of other insect pests, and enhances insecticide resistance management practices through reduction in insecticide selection pressure.

Executive Summary:

This project was a joint undertaking with Agri-Consultants, Mark Carter, President. This independent agricultural consulting firm was called into this area of north-west Fresno after several years of mounting insect pressure in cotton. Of particular concern was the increase in *Lygus* bug densities between 1985 and 1995. Some cotton growers believed the shifting cropping patterns played a role in the increased pest pressure. Almond acreage has increased substantially during the 1990's and the understory vegetation was thought to be one source of *Lygus*.

In 1996 *Lygus* migration was blamed on simultaneous mowing of a large acreage of almond floor vegetation. *Lygus* counts increased from non-economic levels to over 30 counts/50 sweeps. Repeated applications of insecticides (pyrethroids and organophosphate) were required which led to aphid outbreaks (3 additional organophosphate and organochlorine) and beet armyworms (2 additional carbamate and pyrethroids). One producer reported profit losses at over three-quarters of a million dollars.

This project had three objectives:

1. Improve and increase the understanding of *Lygus* ecology as it relates to northwestern Fresno Co. cotton production
2. Improve the management of almond middles to mitigate *Lygus* migration from almonds to cotton
3. Develop and provide educational outreach to almond and cotton producers to improve cross commodity management of *Lygus* bugs

Lygus populations were monitored in orchards, weedy fields, lima beans, and cotton. Weeds were identified and host associations reviewed from the literature. *Lygus* populations were managed successfully through frequent mowing. It is believed that this action prevented the hosts from acting as an optimal resource for *Lygus* as well as destroying incipient *Lygus* populations.

To accomplish the second objective, the community of almond and cotton growers was brought together to discuss the problem. The meeting in late November 1997, outlined the problem and initiated the process of building a consensus within the community and identifying solutions. Almond growers were sympathetic to the plight of their neighbors but were not convinced that almonds were the source. Data collected through this project supported the case that almond understory did act as a source of *Lygus*. Almond growers agreed that frequent mowing of the weedy cover was possible, weather permitting. The idea of chemical "mowing" with Round-up© was discussed and the advantages of light-weight application equipment were

pointed out. The issue of cost of the practices soon surfaced but was quickly put aside. Almond growers were willing to take on the cost of frequent mowing if it provided a solution to the neighbors' problems.

In the spring of 1998, the group reconvened to implement management guideline of frequent mowing of almond understory vegetation. Almond growers took special note of orchards that bordered the cotton and ensuring that these were mowed regularly. Weekly samples were taken from almonds and weedy field sites. Very low populations were noted in almonds, which were mowed at regular frequencies.

The fields bordering the almonds were slated for cotton but due to the lateness of the year and economics involved, lima beans were substituted. Weekly monitoring of fields indicated little migration from almonds but migrations did occur in early September. Sources of the insects might include other cropland, weedy fields, and rangeland.

In addition to the almond-row crop area, another ranch was monitored about 10 miles to the south. This ranch had 1,054 acres of alfalfa hay that was surrounded by cotton. Strips of uncut alfalfa measuring 4 feet wide were left every 300 feet under the solid set sprinkler lines. These strips did little to hold *Lygus* but probably slowed some of the migration. What played a major role in limiting the migration of *Lygus* from alfalfa to cotton was the abundance of uncut alfalfa. Cutting schedules were modified to create a patchwork of harvested alfalfa with 2/3 of the acreage remaining uncut in any particular week. Thus, migration was mostly limited between alfalfa fields. In fields located on the margin of the ranch where migrations were occurring, the population densities were substantially higher.

Educational outreach was limited to two group meetings and individual consolations by Agri-Consultants. Mr. Fred Thomas of CERUS Consulting developed informational material on managed cover crops and their *Lygus* suitability.

Body of Report:

Introduction

Lygus biology is not completely understood but has been studied in CA production systems such as alfalfa[1], safflower[2] and orchard systems[3]. It is our belief that *Lygus* enter orchards when cotton and surrounding crops are no longer available in late summer and fall. *Lygus* enter a weak "diapause" state as pre-sexual adults until late November or December[5]. They may reside in leaf duff and other vegetation residue[7]. What breaks this dormancy is not understood but precipitation may play a role. A minimum of 0.5-inch rainfall is reported for germination of annual broad-leaves and grasses[4]. *Lygus* move onto the developing hosts, feed to reach sexual maturity, breed, and produce the first generation. One to two generations may develop during winter and spring depending on temperature and available hosts. In almonds, host availability is limited by spring mowing, inflicting direct mortality and forcing the adult population into migration.

Lygus has a wide host range including alfalfa, alfalfa seed, cotton, sugar beets, beans, tomatoes, safflower, and numerous broad-leaf weeds found in cultivated and uncultivated fields, orchards, and rangeland. *Lygus* prefers crops other than cotton but migrates to cotton when plant suitability becomes compromised, usually when the crop or plant begins to dry down and die. The concept of managing *Lygus* as a common through regional approaches is not new. Dr. Vern Stern stated in 1967[5]:

> "The grower, faced with rising production costs at all levels must decide if he will rely completely on insecticides to fight *Lygus* and accept the financial burden or if he will look for another method of control….."
>
> "In attacking the *Lygus* problem, chemicals are used when absolutely necessary; but first a major change must be made in farm practices to keep *Lygus* out of cotton"

Lygus hesperus continues to be the key insect pest in cotton production in the West Side of Fresno Co. Costs of managing this pest in 1996 in the San Joaquin Valley are estimated[6] at $13.00/acre with estimated losses of 45,000 bales (ca. 15 million dollars at $0.70/lb). Treatments initiated for control creates of disruption of biological stability and results in secondary outbreaks of spider mites and aphids. In 1996 in the north-western portion of Fresno County suffered a substantial and profit crop loss due to *Lygus* migrations[7]. The migration was blamed on simultaneous mowing of a large acreage of almond floor vegetation. *Lygus* counts increased from non-economic levels to over 30 counts/50 sweeps. Repeated applications of insecticides (pyrethoids and organophosphate) were required which led to aphid outbreaks (3 additional organo-phosphate and organo-chlorine) and beet armyworms (2 additional carbamate and pyrethoids). One producer reported profit losses at over three-quarters of a million dollars.

The association of *Lygus* with almonds has been recognized by PCAs for a number of years but never substantiated. In NW Fresno Co. cotton growers also note that insecticide use has gone from an application of a selective miticide and occasional worm or *Lygus* treatment to annual treatments for *Lygus*. The problem with *Lygus* has become worse since the mid-1980s and an association with increasing almond acreage is noted. Monitoring by Agri-Consultants during winter and spring of 1996 found high population densities in the weeds found in the almond middles. Almonds themselves do not appear to be a host but vegetation between almond rows ("middles") do contain known *Lygus* hosts such as purslane, Russian thistle, lambsquarters, mustards, and London rocket[8].

Materials and Methods

Crop Landscape

Agri-consultants developed a map of cropping patterns for 1998. This map covered an area of 42,000 acres stretching in a north west direction between Interstate 5 and State Highway 33. Frequency histograms were developed to illustrate cropping patterns.

Robertson Farms

Between March and September 1998, weekly samples of almond orchards, weedy fields, and lima beans were collected by Agri-Consultants and Cooperative Extension. Initially 20 ¼ meter samples of orchard duff were collected and placed on a Berlese funnel for extraction of all insects. A sweep net replaced this approach after 2 March 1998. Orchard sampling continued until 21 May 1998.

The original idea was to monitor the cotton that would lie south of a large planting of almonds. However, instead of cotton, lima beans were substituted. Insects were collected with a standard 15-inch sweep net and counted either in the field or taken back to the lab. The nature of the environment precluded many locations from being sampled throughout the year. Weedy fields were destroyed and almond understory was mowed. Therefore data was collected from

numerous sites throughout the year and replicated from the same site over time whenever possible.

Almond growers to the north of Robertson Farms provided regular mowing of vegetation. Because of scheduling around weather events, all almond acreage bordering row crops were managed. No comparison of almonds without mowing was made.

Sumner Peck Ranch

This ranch consists of 5,584 acres of row and field crops. Cotton was sampled weekly using a standard 15-inch sweep net. Data were recorded and several representative fields were selected for comparisons. This consisted of cotton fields located on the margins of the ranch where *Lygus* migrations were not mitigated or fields in the interior of the ranch that took advantage of alfalfa hay as a sink for *Lygus*.

Results

Crop Landscape

The crop map for 1998 is provided as Figure 1. Forty percent of the acreage was dedicated to cotton production, the largest block crop in the area. Almonds, grain and tomatoes followed at around 10% each with pistachio (4%), alfalfa hay (7%), and beans (3%). These seven crops represented 90% of the acreage (Figure 2).

Robertson Farms

Data from almond orchards and two adjacent two lima bean fields are presented in Figures 3 and 4. Only 3 *Lygus* adults were detected in the orchard duff samples between 1/29/98 and 3/2/98. Switching to a sweep net increased the area being sampled and resulted in the detection of populations (Figure 3). The first *Lygus* nymphs were noted on 3 April 1998. Weeds that were noted in association with almond orchards include grasses, mustard, cheeseweed, shepherd's purse, London rocket, filaree, groundsel, and chickweed. The most common vegetation was grass, which is not a good *Lygus* host. Other weeds were found in patches but not in solid stands.

Populations from lima beans indicated very little migration from almonds but migrations did occur from other sources late in the season (Figure 4).

Sumner Peck Ranch

Data from selected cotton fields are presented in Figures 5 and 6. Some cotton fields located on the periphery of the ranch had high *Lygus* populations (Figure 6). However, the cotton fields located near alfalfa in the interior of the ranch had much lower *Lygus* populations. Alfalfa was not specifically sampled for *Lygus*, but numbers were noted on reports. The alfalfa fields had *Lygus* densities estimated between 1 per sweep to 22 per sweep. The greatest population was noted in early July. *Lygus* populations in cotton bordering alfalfa did not exceed treatment levels (Figure 5).

Educational Activities

In 1997, Mark Carter (President, Agri-Consultants) organized a meeting of almond and cotton growers[9] to discuss the management of almond middles to limit migration of *Lygus* from almonds to cotton. During this meeting the importance of mowing and managing the vegetation in the middles to prevent the buildup and migration of *Lygus* from almonds to cotton was

discussed. Empathy from the almond producers to cotton producers was expressed as many producers grow either crops or recently produced cotton. However, understanding of middles management was limited with questions being asked such as "why grow a cover crops", "should we encourage natural vegetation or supplement with some mix", and "what is the best way to manage the middles". In the end, the importance of mowing and preventing weeds and other plants from becoming net sources of *Lygus* was understood, resulting in 1998 in general mowing and a reduction in *Lygus* in the area. There was little interest in using cover crops to manage orchard production practices. When asked why have vegetation in the middles, dust control was the primary reason with some interest as natural enemy habitat. Water infiltration and diversifying orchard habitats were much less important to these growers

The idea of chemical "mowing" with Round-up© was discussed and the advantages of light-weight application equipment were pointed out. The issue of cost of the practices soon surfaced but was quickly put aside. Almond growers were willing to take on the cost of frequent mowing if it provided a solution to the neighbors' problems. Orchards that bordered cotton were placed on a high-priority mowing schedule. Orchards were mowed at lest monthly during April and May.

Educational information was provided to the general public through mass media. Fred Thomas provided information to *Nut Grower*[10], summarizing cover crop choices that minimize *Lygus* buildup. Mark Carter provided an update to *California-Arizona Farm Press* about regional management[11].

Discussion

Managing *Lygus* on a scale larger than individual fields was suggested over 30 years ago. To accomplish such a goal requires cooperation among many parties across a wide area. Coordination among growers and PCAs is complicated and requires additional communication and cooperation. Thus, there must be a strong motivation within the community such as profitability or lack of management options.

At Robertson Farms, the management of neighboring almond orchard vegetation through frequent mowing, prevented large-scale migration of *Lygus* into lima beans. Hosts suitable for *Lygus* population development tend to be "invasive" plant species that are the first colonizers of disturbed soil. Weeds such as tumble weed, London rocket, and mustards are replaced by grasses once cultivation declines in an orchard and mowing is used as the primary form of vegetation management. Thus, newly planted, non-bearing orchards in their first four years could be the most likely to provide *Lygus* habitat. To limit the opportunity for these hosts to establish, new orchards could be seeded with winter ryegrass and subterranean clover. Such an approach could be developed as a cost-share between cotton growers and almond growers.

At Sumner-Peck, the value of *Lygus* source-sink management was clearly demonstrated. By keeping acreage of alfalfa in a *Lygus* receptive condition, alfalfa was maintained as a sink for *Lygus*. This provided relief for cotton by mitigating *Lygus* movement. The question remains, how much alfalfa is required in an area to provide enough *Lygus* habitat so it will act as a sink, not a source.

Summary and Conclusions

Regional management of *Lygus* is possible through the manipulation of plant hosts that serve as sources of infestation into cotton. This project demonstrated that a community can work together to limit the development of a *Lygus* population through the mowing of suitable hosts. It

also demonstrated that within a single ranch, the management of a preferred host, alfalfa could mitigate population movement into cotton.

The recognition that migratory insects such as *Lygus* must and can be managed on a scale larger than individual fields could move IPM strategies into the next step of complexity.

Figure 1. Crop map of NW Fresno Co.

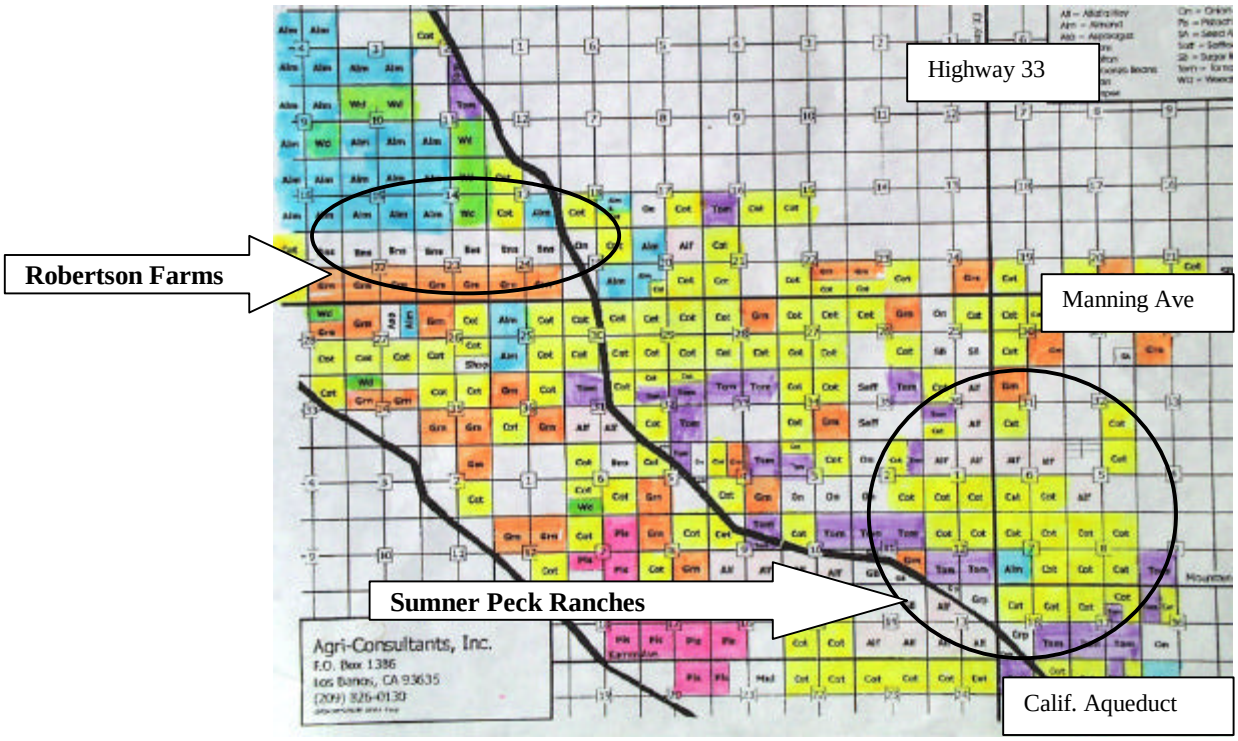


Figure 2. Proportion and acres of land occupied by various crops

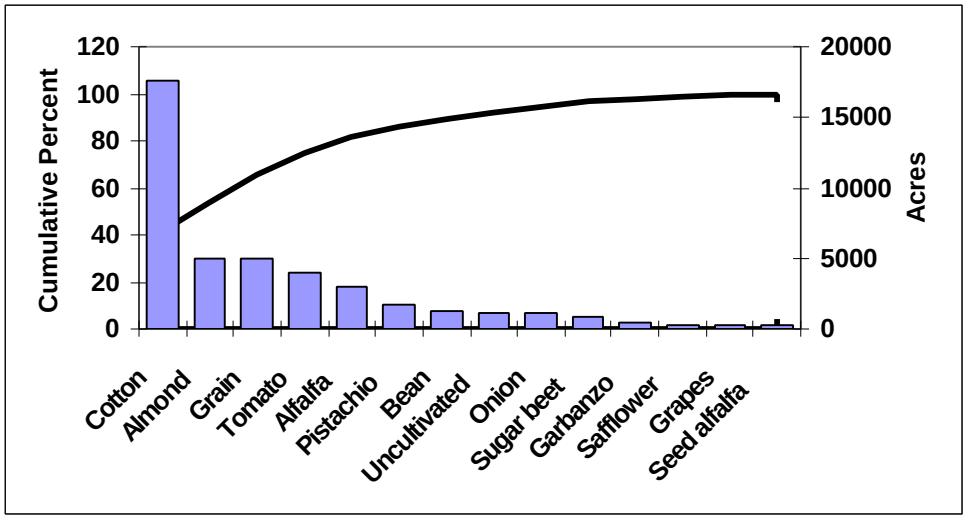


Figure 3. *Lygus* population estimates from two lima bean fields

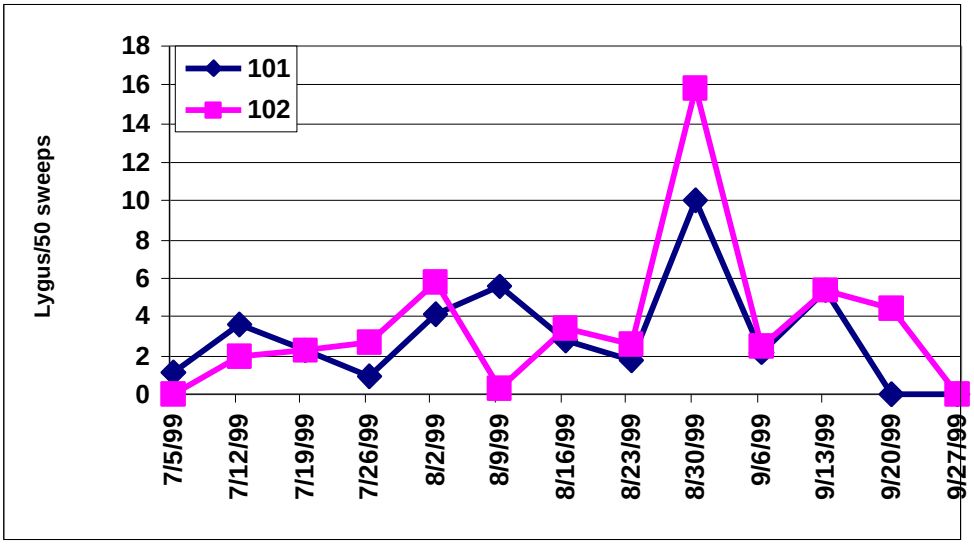


Figure 4. *Lygus* population estimates from vegetation in an almond orchard

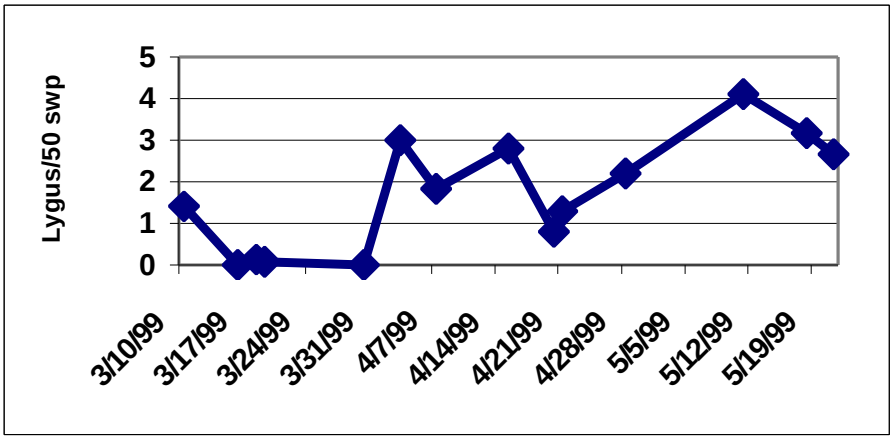


Figure 5. *Lygus* population from cotton in the interior of a ranch

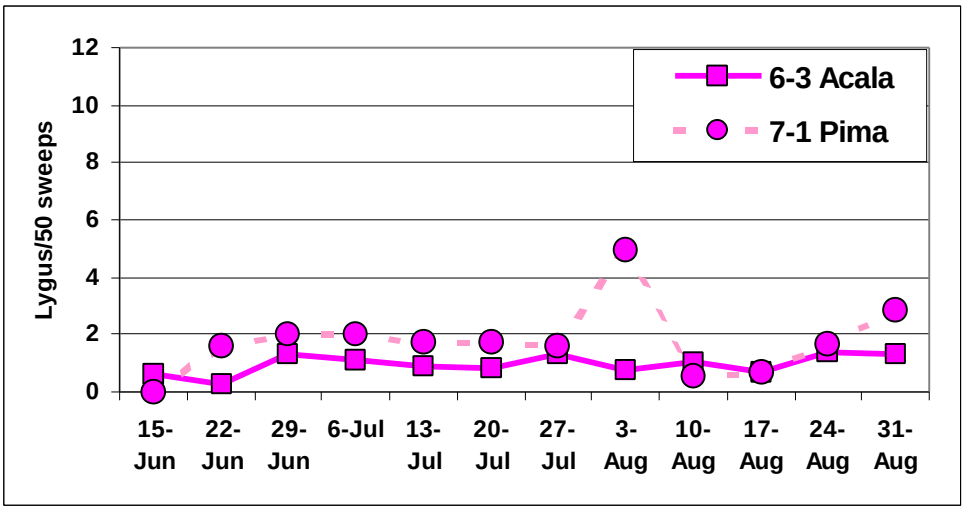
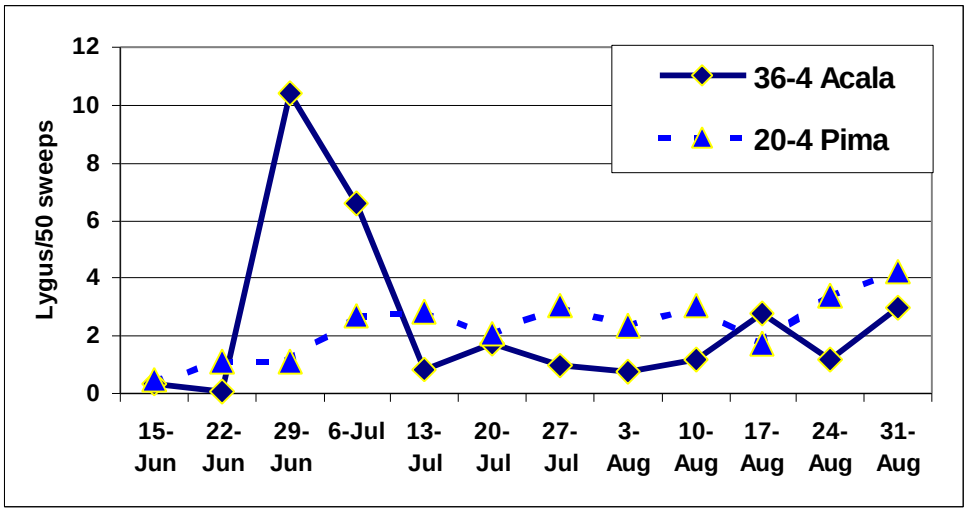


Figure 6. *Lygus* population estimates from cotton on the periphery of a ranch



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[11] Carter, Mark. 1998. Crop diversity often requires look to unusual pest sources. California-Arizona Farm Press, December 19, 1998, page 8.

List of Publications Produced

Thomas, F., C. Ingels, and L. Hendricks. 1998. Cover cropping in nut crops. Nut Grower, August 1998: pp. 6-7.

Carter, Mark. 1998. Crop diversity often requires look to unusual pest sources. California-Arizona Farm Press, December 19, 1998, page 8.